NOTES FROM PACIFIC COAST OBSERVATORIES.

On the Cause of the Characteristic Phenomena of Sun-Spot Spectra.

In considering the characteristic features of the spectra of sun-spots, three points especially attract attention:—

1. The fact that certain lines in the spectrum of a given element are strengthened, while others are weakened; the remainder of the lines being unaffected.

2. The inclusion of all the strengthened lines within the visible spectrum, none of them occurring in the ultra-violet, and their predominance in the red, yellow, and green.

3. The relatively great intensity of the continuous background of the spot spectrum in the less refrangible region.

From our general knowledge of spectra corresponding to various temperatures we are aware—

1. That in passing from a high temperature to a lower temperature, certain lines are strengthened, some are unaffected, and others are diminished in intensity.

2. That such a reduction of temperature is accompanied by an increase in the relative intensity of the less refrangible lines, and a shift of the maximum of a continuous spectrum toward the red.

The general correspondence of these two groups of facts led us to seek for an explanation of the spectra of sun-spots, on the hypothesis that the metallic vapors within the spots have a temperature lower than that of the photosphere.

The investigation was begun with the aid of a synchronous rotating arc, of Crew's design, which permits the spectrum of the alternating arc to be photographed at any desired phase. Subsequently an ordinary arc was employed, with currents of thirty amperes and two amperes respectively. The lines in the spectra of iron, titanium, vanadium, chromium, manganese, and other metals characteristic of sun-spots, were found

to show changes of intensity similar to those observed in spots, when passing from high phase to low phase, or from large currents to small currents. All the evidence favored the view that the effect of such variations in the arcs is to lower the temperature. This conclusion was subsequently confirmed with the aid of the flame of the arc and with an electric furnace. In the latter the metals are volatilized within a carbon tube, the outer wall of which is heated by a powerful electric arc. At the low temperatures obtained within the tube spectra closely resembling the spectra of the corresponding elements in sun-spots have been photographed.

The results are given in full in *Contributions from the Solar Observatory,* No. 11. They may be summarized as follows:—

Considering first the lines strengthened in sun-spots and those strengthened in the two-ampere arc or in the flame of the arc, we have the following table:—

Element.	No. of Lines Strengthened in Spots.	No. of Lines Strengthened in Weak Arc.	Unchanged Weak Arc.
Ti.....	88	83	5
Cr.....	46	42	4
Fe.....	19	18	1
V.....	56	52	4
Mn.....	11	9	2
	220	204	16

A comparison of the lines weakened in spots with the same lines in the spark and two-ampere arc or flame gives the following result:—

Element.	No. Lines Weakened in Spot.	No. These Enhanced in Spark.	No. Not Changed in Spark.	No. Diminished in Weak Arc.	No. Not Seen in Weak Arc.	No. Not Changed in Weak Arc.
Ti.....	8	8	0	8	0	0
Cr.....	10	10	0	6	4	0
Fe.....	13	10	3	9	3	1
Mn.....	1	1	0	1	0	0
	32	29	3	24	7	1

It is thus evident that more than 90 per cent of the lines that are strengthened in our photographs of sun-spot spectra, and included in this investigation, are strengthened in passing from a thirty-ampere arc to a two-ampere arc or to the flame.

A similar proportion of the lines that are weakened in sun-spots are weakened under the same conditions. We have also found that the lines whose intensities are unchanged in sun-spots are, speaking generally, unchanged under the conditions named. As a further fact, of great importance in its bearing upon the temperature of the vapors in sun-spots and the classification of stellar spectra, we also find that over 90 per cent of all the "enhanced" (spark) lines included in our tables are weakened or absent in the two-ampere arc and in the flame.

We conclude that the temperature of the vapors in sun-spots is probably below that of the same vapors in the ordinary reversing layer. As we have recently shown that the spectra of third-type stars closely resemble spot spectra, and as this resemblance is greatly enhanced through our recent discovery of the titanium oxide fluting, which begins at λ 5597.9, in our photographs of spot spectra, further investigations along these lines seem likely to prove fruitful.

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FINLAY'S PERIODIC COMET (1906 *d*).

This comet was discovered by FINLAY in 1886. It returned to the Sun in 1893 and 1900, and was rediscovered on its third return by KOPFF, of Heidelberg, on the morning of July 17, 1906. A search ephemeris had been computed by M. FAYET, of Paris, and published in the same number of *Astronomische Nachrichten* with the printed announcement of discovery.

The comet was looked for at the Lick Observatory on July 20th, when it was easily seen in the 3-inch finder of the 12-inch equatorial. Since then it has been observed a number of times, the last at present writing (September 20th) being on September 16th. From the time of rediscovery it grew continuously brighter until about the middle of August; since then it has grown fainter, but at no time was it visible to the naked eye. On July 20th there was a faint nucleus of about the twelfth magnitude, surrounded by a diffuse nebulous mass. This condensation was barely of magnitude 13.5 on September 16th. No tail had been found at the time of the last observation.

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